The Impact of Tolls on Freight Movement for I-81 in Virginia

EXAMINING THE POTENTIAL FREIGHT DIVERSION IMPACT OF TOLLING ON I-81 IN VIRGINIA

Final Report

Prepared for

George Conner, Director for Rail

Prepared by

Reebie Associates

with

Atherton, Mease & Co.

This page intentionally left blank

Study Participants

Department of Rail and Public Transportation

- Ranjeet Rathore, Manager Special Projects

Virginia Department of Transportation

- Erik Johnson, Transportation Planning Engineer

Reebie Associates

- Joseph Bryan, President
- James Blair, Manager
- Lexcie Lu, Transportation Analyst

Atherton, Mease & Co.

- Susan Atherton, President

This page intentionally left blank

Table of Contents

1. Executive Summary 3
2. Introduction 6
3. Study Results 6
   3.1 Predicting Loads Diverted 7
   3.2 Predicting Vehicle Miles (VMT) Diverted 9
   3.3 Predicting Market Segments Affected: Commodity 11
   3.4 Predicting Market Segments Affected: Mileage Blocks 12
   3.5 Predicting Impact on Other Routes 13
   3.6 Predicting Impact on Local Freight Operations 16
4. Analysis Methodology 19
   4.1 Motor Carrier Interviews and Surveys 19
   4.2 Diversion Modeling Methodology 23
5. Conclusions 27
   5.1 Commodity Profile of Diversions 27
   5.2 Distance and Route Profile of Diversion 28
6. Implications for Virginia Economic Development 29
7. Policy Implications 29

Appendix A 35

Appendix B 39

Appendix C 41

Appendix D 45

This page intentionally left blank

The Impact of Tolls on Freight Movement for I-81 in Virginia

FINAL REPORT

This page intentionally left blank

1. Executive Summary

Interstate 81 in the Commonwealth of Virginia is a critical artery in the nation's highway network. It serves as a primary corridor for tourism and local economic activity, and as a vital conduit for through freight providers connecting the growing industrial south to the consuming markets of the Northeast. The Commonwealth is evaluating a wide range of improvement alternatives for the highway as a means of increasing capacity, and separating through freight volumes from local access.

Very recently, Virginia has selected a Public Private Transportation Act (PPTA) proposal from STAR Solutions for I-81 that seeks to finance a portion of the construction costs with tolling. While the STAR Proposal recognizes the potential for tolling to divert commercial vehicle traffic to alternative routes, the impact of these diversions needed to be quantified.

The purpose of this study has been to quantify the potential for truck diversions from I-81 at various rates of tolling, and to identify toll policy issues for the Commonwealth.

The Reebie analysis consisted of two distinct elements that were designed to extract qualitative and quantitative results. The first major element of the analysis was a series of interviews and surveys of motor carriers operating nationally, and along the I-81 corridor. These contacts were designed to establish what factors were important to motor carriers in determining route selection, and to ascertain the impact of highway tolling in the evaluation of route alternatives. The second primary element was the application of a customized diversion model that would reflect the decision logic of motor carriers operating in the corridor, and serve as a proxy for the thousands of routing decisions made by truckers of all sizes, everyday.

The application of this model revealed that the number of vehicles diverted from I-81 increases approximately linearly with the cost of tolls per mile, provided that the tolls are applied in a uniform manner. The analysis addressed level of tolls between one penny and 40 cents per mile. Up to 12 cents, the diversion impacts are small, accounting for approximately 16% of vehicle miles and 24% of the loads. The vehicle miles diverted sharply increases between 12 and 30 cents per mile, before leveling off again as only truly captive traffic remains at toll levels above 30 cents.

In the analysis, no significant difference in rates of diversion was found between commodity groups, with the exception of coal, which shows larger diversion than other commodities at lower toll rates. In terms of revenue however, trucks doing business in

Virginia were found to be shouldering about a constant one-third of the total toll burden up to toll rates of 20 cents per mile, beyond which both anticipated revenue and the share of cost borne by interstate truckers decreases sharply.

The impact of the identified I-81 diversions would be an increase in truck traffic on a number of routes, including I-95, I-64, U.S.11 and U.S.29. The results of this analysis suggest that it is unlikely that any of these alternative routes will experience a noticeable increase in truck traffic at toll levels below $0.20 per mile, with the exception of U.S.11, which at that toll level is likely to see a increase of approximately 84 trucks per day.

Presupposing that the Commonwealth's policy objective would seek to minimize collateral economic impacts, a toll level of between 10~15 cents per mile is likely to be acceptable. Alternatively, if financial priorities demand that highway users pay the greatest proportion of infrastructure costs, a toll level of between 15~20 cents per mile is likely to produce optimal results. The analysis strongly suggests however, that tolls of more than 20 cents per mile would prove counterproductive, both from a financial and economic development standpoint.

Based on the findings of this analysis, we conclude that:

- *Appropriate toll levels will help manage risk to Virginia industries*
- *Appropriate toll levels will help manage risk to Virginia's primary and secondary roads.*
- *Appropriate toll levels will help manage risk to I-81 revenue.*
- *Appropriate mitigation measures will help reduce the risk to Virginia's bulk industries.*
- *Toll exclusions for empty truck movements do not appear to offer substantive relief.*
- *Toll exclusions for local freight movements may be helpful in mitigating primary and secondary road impacts.*
- *Exclusion for specific commodity classes (other than perhaps coal, metallic and non-metallic mineral traffic) does not appear necessary.*

The application of tolls to I-81 engenders a number of risks that could impact the Commonwealth economy, and the safety of its citizens. The measured application of sound toll policy could moderate many of these impacts, and still permit the dual goals of improved highway safety and capacity to be realized.

The economic impact of Virginia I-81 Tolling is likely to be felt only in the parts of Virginia whose accessibility would be severely impacted by the I-81 tolls. The impact is likely to be most severe in those areas where the economy is not broadly diversified, and whose primary industries are heavily dependent on truck transportation.

The results of this analysis suggest that in addition to the work now underway through the I-81 National Environmental Protection Act (NEPA) analysis, a more comprehensive economic analysis –including the development of a regionally calibrated input-output model – would be an appropriate next step in determining the impact of I-81 tolls on the Virginia economy and the well being of its citizenry.

2. Introduction

Corridor congestion presents a particularly vexing problem to many states. While the investments required to remove "bottlenecks" are frequently local, the implications of a free-flowing highway network are clearly national. Departments of Transportation are often faced with investing scarce resources in infrastructure that benefits adjacent or even remote regions, but provides little economic benefit to the state itself. As a result, states are evaluating the application of "user fees" such as highway tolls, to align investment financing with economic utility.

Interstate 81 in the Commonwealth of Virginia is a critical artery in the nation's highway network. It serves as a primary corridor for tourism and local economic activity, and as a vital conduit for through freight providers connecting the growing industrial south to the consuming markets of the Northeast. Through Virginia's Public-Private Transportation Act (PPTA) process, the Commonwealth is evaluating a wide range of improvement alternatives for the highway as a means of increasing capacity, and separating through freight volumes from local access.

The Virginia has selected (with conditions) a PPTA proposal from STAR Solutions for I-81 that seeks to finance a portion of the construction costs with highway tolls. While the STAR Proposal recognizes the potential for tolling to divert commercial vehicle traffic to alternative routes, the impact of these diversions needed to be quantified.

The purpose of this study has been to quantify the potential for truck diversions from I-81 at various rates of tolling, and to identify toll policy issues for the Commonwealth.

3. Study Results

To determine the impact of tolling, on I-81, Reebie Associates applied a shortest-path model developed by Oak Ridge National Laboratory to a 2003 version of its TRANSEARCH® database. These data were coupled with results from Reebie's truck (TCAM) cost model and information obtained from a survey of trucking firms operating in the corridor. The inputs were combined into a diversion model which routed traffic based on the least cost alternative. The non-linear model calculated trucking costs based on mileage, time, route, toll, expected congestion, equipment type, driver type, and size of carrier. The complex cost functions reflected the routing decision process used by motor carriers, and which translates into a realistic rate of diversion at a given toll cost. The diversion results allowed Virginia constituents to see which lanes and commodity -- and by implication which local economic sectors -- could be aversely affected by the imposition of tolls.

The Reebie Diversion Model predicted that the number of vehicles diverted from I-81 increases approximately linearly with the cost of tolls per mile, provided that the tolls are applied in a uniform manner. However, the vehicle miles diverted was found to follow an 'S'-curve with respect to toll cost, consistent with accepted transportation economic theory. This difference is due to a large percentage of local traffic (with correspondingly short I-81 mileage) being diverted first – at toll rates between 1~12 cents -- followed by mainly interstate traffic being diverted between 12~30 cents. No significant difference in rates of diversion was found between commodity groups, with the exception of coal, which shows larger diversion than other commodities at lower toll rates. In terms of revenue, trucks doing business in Virginia were found to be shouldering about a constant one-third of the total toll burden up to a rate of 20 cents per mile, beyond which both anticipated revenue and the share of cost borne by interstate truckers decreases sharply.

Presupposing that the Commonwealth's policy objective would seek to minimize collateral economic impacts, a toll level of between 10~15 cents per mile is likely to be acceptable. Alternatively, if financial priorities demand that highway users pay the greatest proportion of infrastructure costs, a toll level of between 15~20 cents per mile is likely to produce optimal results. The analysis strongly suggests however, that tolls of more than 20 cents per mile would prove counterproductive.

3.1 Predicting Loads Diverted

The binary routing model predicted that there is roughly a linear relationship between the toll cost and the loads diverted ($y = 1.1x+0.13$ with $R^2 = 0.98$). This suggests that there is a reasonably uniform distribution of average detour costs per mile across the entire spectrum of truckers. It is in line with our expectation that some trucks will find it easy to locate alternative routes, while others will find it much more difficult. This result is shown in Figure 1 and Figure 2.

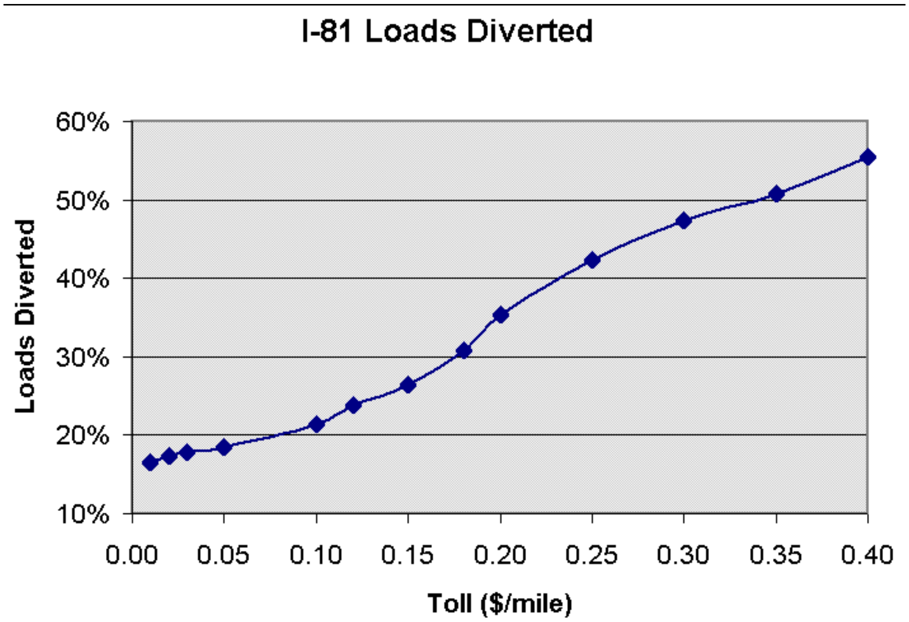


Figure 1: **I-81 Trucks Diverted at Various Toll Amounts (2003 Volumes)** [1]

[1] The total volume figures reflected were developed from VDOT traffic counts for I-81 in 2003, and a Reebie Associates TRANSEARCH dataset constructed specifically for this analysis. This dataset began with VDOT owned TRANSEARCH 1998 data, indexed to 2001 by commodity and geography, and then indexed to 2003 using VDOT traffic counts. The actual traffic count adjustment factors are provided in Appendix B to this report.

The diversion estimates in this analysis reflect the volume of trucks and VMTs that would be diverted if the toll application ***were imposed in 2003***. The analysis was conducted in this fashion to permit the diverted VMT impacts to be measured for alternative highways against *known* volume figures. Using forecast figures for the I-81 volumes alone would have required having similar forecast figures for all alternative routes.

The volume figures reflected in Figure 2 can be indexed to reflect Load and VMT impacts in future years based on VDOT forecasts for I-81. Using forecasted traffic count data supplied by VDOT for I-81 for 2010 and 2020, the Load and VMT factors reflected in Figure 2 can be adjusted for any given toll level by multiplying by factors of 1.481 and 1.880 respectively.

Interestingly, the vertical axis intercept was not found to be zero – suggesting that some trucks that are currently taking I-81 despite the fact that their utility is sub optimized. It is likely that the small percentage of loads represented in this category reflect the package express and just-in-time logistics movements that have limited routing options because of fixed terminal networks, trucks with hazardous cargoes that have prescribed routes, or movements requiring special security.

Toll Cost Per Mile	Loads Diverted	Percent of Loads	I-81VMTs Diverted	Percent of VMTs
$ 0.05	762,477	18%	33,556,408	9%
$ 0.10	882,824	21%	48,196,645	14%
$ 0.12	979,625	24%	56,676,929	16%
$ 0.15	1,087,198	26%	82,121,158	23%
$ 0.18	1,268,790	31%	109,966,819	31%
$ 0.20	1,458,151	35%	127,668,342	36%
$ 0.25	1,746,742	42%	204,494,431	58%
$ 0.30	1,952,905	47%	236,868,280	67%
$ 0.35	2,094,475	51%	264,801,528	75%
$ 0.40	2,286,875	55%	287,394,756	81%
Infinite	4,126,314	100%	355,162,922	100%

Figure 2: **I-81 Trucks Diverted at Various Toll Amounts (2003 Volumes)**

3.2 Predicting Vehicle Miles (VMT) Diverted

While the distribution of average detour cost *per mile* is uniform, the mileage distribution is far from uniform (See Section 3.4). As the Virginia Toll Survey and routing analyses indicate, local trucks that are traveling only a few miles on I-81 will divert as soon as a toll is imposed – provided that the toll is applied uniformly at every entrance and exit. However, medium distance (800~1,500 miles) moves that travel the entire length of I-81 are unlikely to divert until toll costs become significant at about 15~20 cents per mile.

This accounts for the faster increase in VMT diversions in the range of 12~25 cents, even though load diversions have remained linear. Figure 3, demonstrates this relationship.

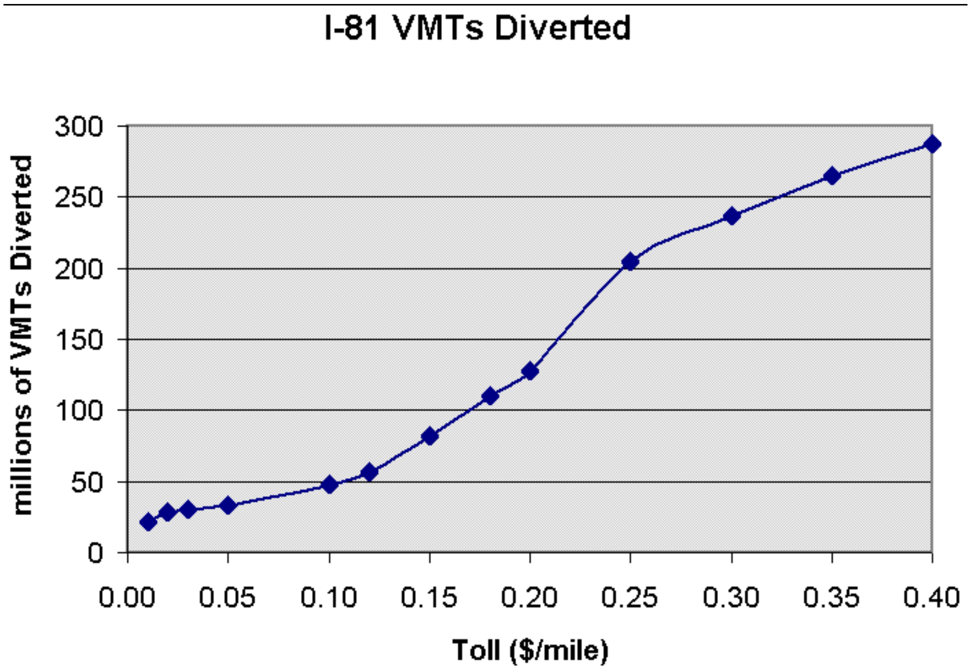


Figure 3: I-81 Vehicle Miles Diverted at Various Toll Amounts (2003 Volumes)

The results shown are consistent with transportation economic theory, which suggests that a price/demand trade off will generally follow an ‘S’ curve. Cubic curve fitting demonstrated an R^2 of more than 0.99. Demand is generally inelastic until the price reaches a critical range, where the demand is highly elastic; once most of the traffic has diverted, the demand become inelastic again as only captive traffic remains. Revenue “maximizers” will seek to exploit this by setting the price at the point just below the highly elastic range – about 12~15 cents per mile in this case.

3.3 *Predicting Market Segments Affected: Commodity*

In general, no particular commodity segment was found to be particularly susceptible to tolls or diversions. The differences between different commodity (2-digit STCC)[2] segments shown in Figure 4 is unlikely to be statistically significant, except in the case of ores, coal, aggregates, and instruments. In the case of ores, because it is an extremely bulky commodity and has very specific production and consumption sites, there is little expected variation in the possible routes that could be taken, and the diversion is likely to be "all-or-nothing." Similarly, coal and aggregates are commodities that generally travel locally, and thus a high proportion (i.e. those that are not divertible to U.S. 11) are likely to be relatively captive. Although the diversion model does not predict this, some of the flows are likely to disappear and reappear due to geographic sourcing of coals mines and gravel pits proximate to I-81. Instruments makes up a very small percentage in terms of total freight flow, and the high percentage of captive flows has relatively little significance to the analysis overall.

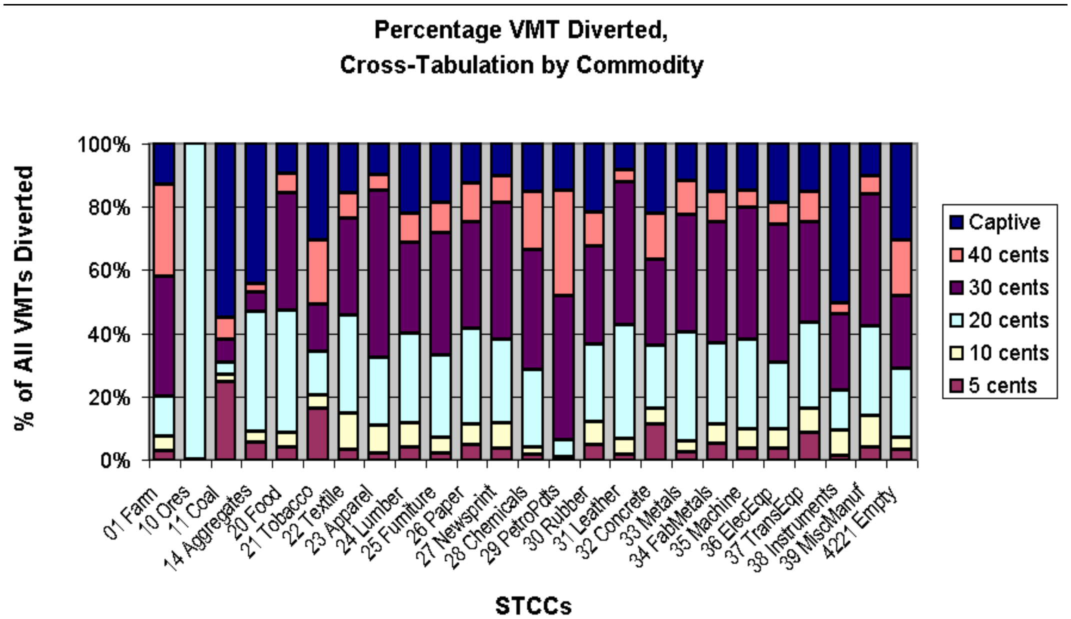


Figure 4: **Percentage of Vehicle Miles Diverted, by Commodity (2003 Volumes)**

[2] Standard Transportation Commodity Codes at the 2-digit level generally corresponds to the Standard Industrial Coding system also at the 2-digit level.

As demonstrated in Figure 4, the toll rates that are least likely to hurt traffic flows (and by implication, Virginia economies), is between about 10~20 cents per mile, above which serious diversions begin to occur in all commodity segments. The exception to this is the coal sector, which shows significant diversions at 5 cents per mile. Mitigation measures such as toll relief or routing dictation should be considered for coal haulers.

3.4 Predicting Market Segments Affected: Mileage Blocks

The results of mileage block market segment analysis are shown in Figure 5. As expected, toll rates between 1~10 cents divert a minimal amount of traffic in all mileage block market segments, except between 0~99 miles – local traffic that are easily diverted to U.S. 11. Medium distance traffic begins to divert heavily when toll costs exceed 20 cents.

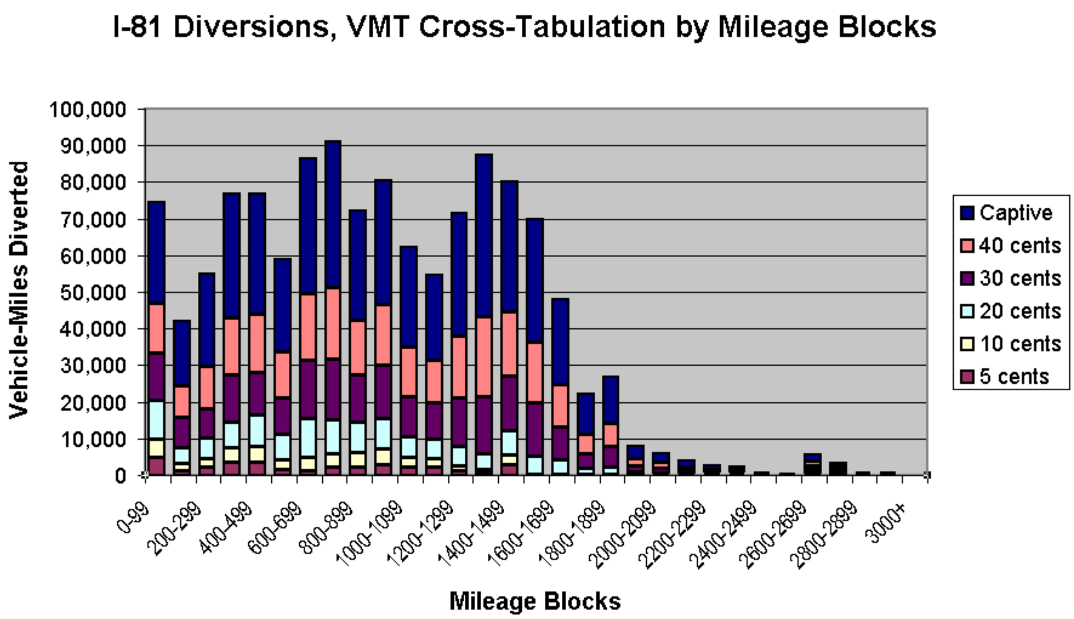


Figure 5: I-81 Vehicle Miles Diverted for Different Origin-Destination Distances (2003 Volumes)

3.5 Predicting Impact on Other Routes

Diversions from I-81 as a result of highway tolling generate a multitude of routing changes that alter base level VMT and Average Annual Daily Truck Traffic (AADTT) for numerous Virginia and non-Virginia roads and highways. Some routes receive additional traffic, while on others the volumes are reduced.

To calculate the incremental impacts of the diversions on Virginia's primary and secondary routes, we matched the summary data generated for the market segment analyses (see Section 3.4) with routing data generated by the Oak Ridge National Laboratory Model (ORM, see Section 4.2.1), and base-level 2003 AADTT data supplied by the Virginia Department of Transportation (VDOT) for I-81 and several other Virginia arterials. This analysis identified the preferred alternative route of the diverted traffic, and provided the incremental VMT and AADTT impacts to Virginia's primary routes, resulting from the application of tolls at various levels.

At the moderate truck toll level of $0.20/mile, 8.8% of Virginia I-81 truck miles (Truck VMT) would be diverted to I-95, representing a 16% increase in the I-95 AADTT (see Figure 6, column 6). Another 13% of the diverted I-81 truck-miles moves to other Interstates outside Virginia, and an additional 13% moves to non-Interstate routes outside the Commonwealth (see Figure 6 column 2).

The net result is that the motor carrier industry is likely to see a system wide mileage increase of up to 1.1% (Figure 6 column 3 under "Other VMT Impacts") under this scenario. The distribution of these mileage increases is unlikely to be uniform however, as some Virginia truckers will likely to see increases of more than 5%, while most through trucks are unlikely to see any measurable increase at all.

	VMT Change (Millions)	% of I-81 VMT	% of Total VMT	2003 Baseline AADTT	2003 AADTT Change	2003 AADTT % Change
Primary Virginia Interstates						
Virginia I-81	-106.5	-35.3%	-5.5%	11,305	—	—
Virginia I-64	6.9	2.3%	0.4%	3,403	289	8%
Virginia I-95	26.4	8.8%	1.4%	10,618	1,666	16%
Other Virginia Highways						
Virginia U.S. 11	2.7	0.9%	0.1%	256	84	33%
Virginia U.S. 29	0.9	0.3%	0.0%	1,592	44	3%
All Other	12.3	4.1%	0.6%			
Non-Virginia Highways						
Interstate	40.2	13.3%	2.1%			
Non-Interstate	39.8	13.2%	2.0%			
Other VMT Impacts [1]						
Interstate	-12.3	-4.1%	-0.6%			
Non-Interstate	-10.4	-3.4%	-0.5%			
Total	0.0	0.0%	0%			

[1] Includes the impact of additional mileage from rerouting, and I-81 mileage avoided in other states.

Figure 6: Truck VMT[3] Impact of $0.20/mile Toll on Virginia I-81

The impact of the I-81 diversions would be an increase in truck traffic on a number of routes. Citizens and motorists are likely to perceive increases in truck traffic not in terms of additional vehicle-miles traveled (VMT) but as a percentage increase of daily truck counts (AADTT). Increasing the daily truck count by ten on a rural route that previously only carried ten trucks per day represents a "doubling" of truck traffic, while a similar increase on a busy interstate would hardly be noticed. From this perspective, the

[3] VMT Impact by route in this study was estimated based on the Oak Ridge Routing Model. The model can double-count mileages where Interstates (or other routes) have more than one route designation. For example, I-81 and I-64 share a single alignment between Lexington, VA and Staunton, VA for a distance of 31 miles. The model would then attribute 31 miles savings against I-81 and another 31 miles saving against I-64 if one truck was removed from the shared segment. This could generally lead to an overestimation of traffic impacts on routes other than I-81 (except on I-64 which is co-routed with I-81). The overstatement is small however; amounting to an average error of approximately 10% of I-81 diverted VMT.

percentage change of highway AADTT would give some indication of the perceived impact of diverted trucks on alternative highways.

The significant impact to U.S. 11 is seen at all toll levels (see Figure 7), which experiences roughly a one-third increase in truck traffic at 20 cents. The impacts to other highways do not become significant until I-81 tolls reach levels above $0.20 per mile.

In absolute terms however, the impact to U.S. 11 is relatively minor. The highway carried on average 256 trucks per day in 2003[4]; tolling at $0.20 per mile would add an additional average of 86 trucks per day – a relatively small volume when compared to the average of 1,592 trucks per day on the nearby U.S. 29[5].

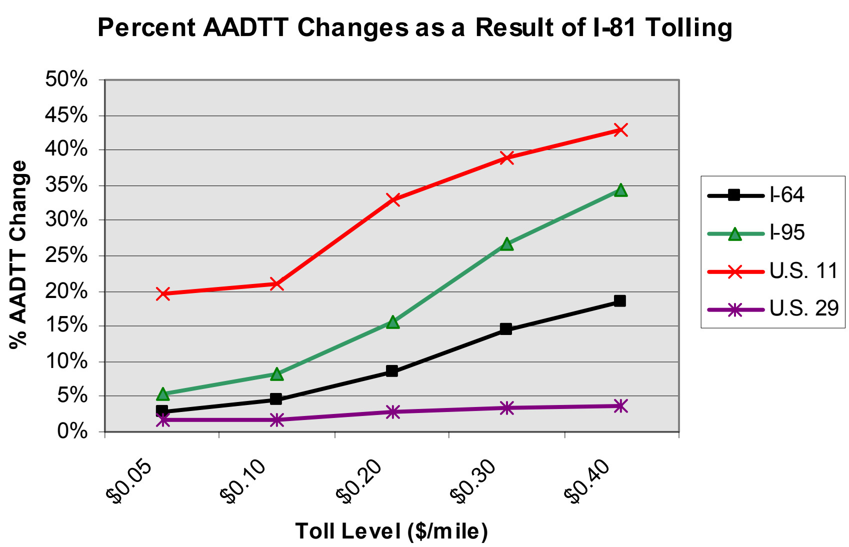


Figure 7: Daily % Truck Count Increments as a Function of Toll Level

[4] Reflects average of 2003 AADTT for all Virginia portions of U.S. 11. Data supplied by VDOT.

[5] Ibid.

Alternatively, the projected VMT impact of I-81 diversions represents a superior measure of an increased highway maintenance burden. For most of the selected routes, the VMT impact becomes significant at toll levels between 10~20 cents per mile (see Figure 8).

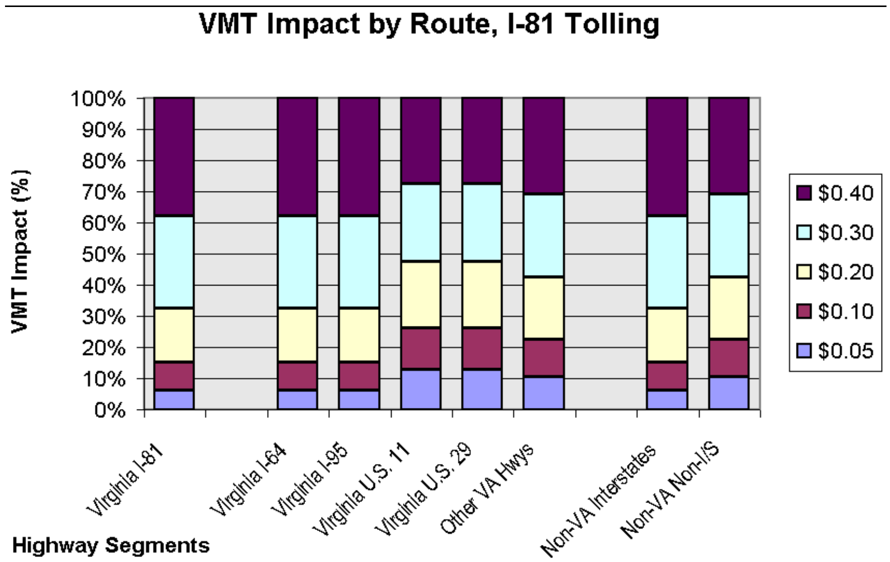


Figure 8: Percent Vehicle-Miles Burden as a Function of Toll Level[6]

These results suggest that it is unlikely that any of the selected routes will experience a noticeable increase in truck traffic at toll levels below $0.20 per mile, with the exception of U.S.11. Due to the currently low existing levels of truck activity on this highway, at a toll level of $0.20 per mile, U.S.11 is likely to see a 33% increase in daily truck counts.

3.6 *Predicting Impact on Local Freight Operations*

Using the origin-destination shipment data, it is possible to identify to what extent trucks traveling to and from Virginia ("Virginia Customers" or "VA") are bearing the toll

[6] I-81 VMT impacts reflect *negative* changes in VMT. For purposes of illustration, an absolute value is portrayed.

burden vis-à-vis "Interstate Truckers" (trucks with origins and destinations outside the Commonwealth or "Non-VA" Customers). For each toll scenario, the total tolls collected were divided into shipments to, from and within Virginia versus those outside the Commonwealth, and the results charted. It is then possible to optimize the toll revenue mix by choosing the scenario that produced the least proportion of Virginia tolls and maximum toll revenue.

The current I-81 NEPA (National Environmental Protection Act) Analysis should yield sufficient data to determine the impact of diversions (i.e. the cost of externalities) to local communities. This data would permit the selection of toll level that would minimize local collateral impacts while generating sufficient revenue from interstate travelers to fund the expansion. While the scope of this project did not require a full cost-benefit analyses, some preliminary results are presented here that would help the Virginia Department of Transportation analysts determine the optimal toll rate schedule.

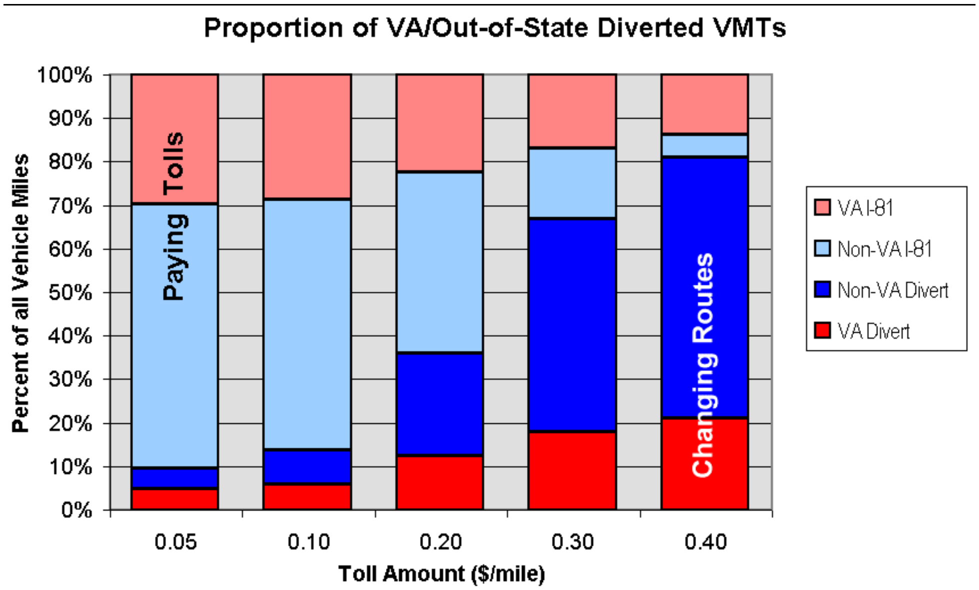


Figure 9: Effect on VA and Interstate Trucker Behavior at various Toll Levels (2003 Volumes)

As demonstrated in Figure 9, the toll burden on non-Virginia truckers begins to decrease substantially at a point between 10~20 cents per mile, and falls below that incurred by Virginia local truckers at 30 cents per mile. A toll level slightly between 10 and 20 cents per mile would seem to place the majority of the toll burden on through trucks while minimizing collateral impacts on local streets.

However, from a revenue maximization standpoint, as shown in Figure 10, by tolling at 20 cents per mile, the toll authority stands to obtain almost 46% more revenue than at 10 cents per mile. At both 10 and 20 cents, about 33% of the revenue comes from Virginia truckers, while at 30 cents, Virginia customers account for approximately half the revenue.

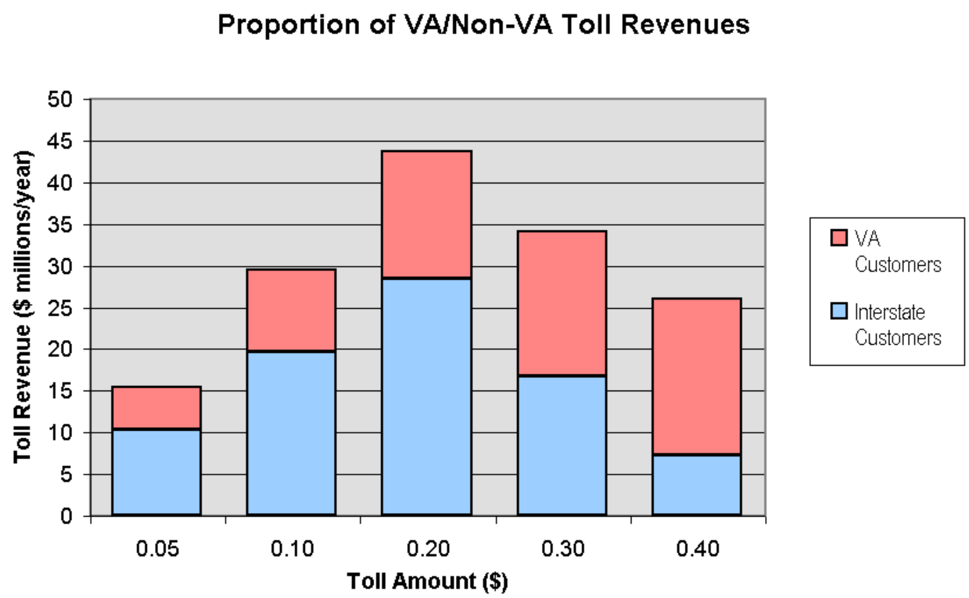


Figure 10: **Source of Toll Revenues (2003 Volumes)**

Given the above analyses, the evidence points to a recommended toll level of between 10~20 cents per mile. If the policy objective is to minimize collateral impacts, tolls close to the lower end of the range is likely to be suitable; if the priority is in forcing the users to pay a greater proportion of infrastructure costs, tolls closer to the upper end is likely to be favored. The analysis strongly suggests that tolls of more than 20 cents per mile would prove counterproductive.

4. Analysis Methodology

The Reebie analysis consisted of two distinct elements that were designed to extract qualitative and quantitative results. The first major element of the analysis was a series of interviews and surveys of motor carriers operating nationally, and along the I-81 corridor. These contacts were designed to determine what factors were important to motor carriers in route selection, and to establish the evaluation criteria and metrics used within the industry to compare toll and non-toll route alternatives.

The second primary element was the application of a customized diversion model that would reflect the decision logic of motor carriers operating in the corridor, and serve as a proxy for the thousands of routing decisions made by truckers of all sizes, everyday.

4.1 Motor Carrier Interviews and Surveys

To understand the impact of tolls in the trucking industry it is necessary to understand certain background aspects of the motor carrier industry. These aspects include defining types of equipment ownership, types of drivers and driver pay, routing and access to technology, shipment commodities, billing methods, and toll payment and driver reimbursement mechanisms.

4.1.1 Motor Carrier Operating Models

Trucking companies employ two primary strategies to manage drivers and equipment: (1) a company owned equipment with carrier paid employees as drivers, and (2) an owner-operator system where the truck, and sometimes the trailer, is owned by an outside party who either drives the vehicle or employs independent drivers. Companies utilize one or both strategies to minimize costs, to expand geographic reach, or to accommodate seasonal and geographic traffic imbalances.

The employment terms between driver and company can affect operating policies, and hence the decision to utilize toll roads.

4.1.1.1 Driver Pay Methods Impact Routing Choices

Independent drivers are paid in a variety of ways; the two most common methods are (1) on a "cents per mile" (mileage paid) basis, or (2) as a straight percentage of freight revenue billed to the customer (piecework). Local and regional drivers are generally paid by the hour, although some are paid based on a combination of miles and the activities performed (e.g. pick-up and delivery).

Piecework drivers commonly operate in a manner that provides them the highest level of economic benefit. This means these drivers will evaluate the impact of tolls, distance, fuel price, and time in a cost benefit relationship, and select a routing that provides the greatest overall return. Mileage paid drivers may be compensated based on either actual miles driven or on "billed" (shortest route) miles. A significant number of shipper contracts pay the carrier based on the shortest route mileage, rather than the "practical miles" (likely to be driven) or the miles actually driven. The difference between these methods often represents a significant amount of money for both the company and the driver. Most motor carrier companies pay their drivers based on the mileage they bill the customer, rather than based on the miles the driver has actually driven. Thus mileage paid drivers will generally seek to minimize overall mileage unless the additional mileage is offset by highway toll.

Like the independent drivers leased to larger firms, owner operators must individually bear the cost of operations. And like their independent counterparts, owner operators will evaluate the impact of tolls, distance, fuel price, and time to determine which routing provides the greatest overall return for a given load.

For company drivers, the circumstances are quite different. The company absorbs fuel, equipment, and toll expenses, and thus driver routing decisions merely consider the cost of time associated with a more circuitous alternative.

The aspects of pay methods and equipment ownership play a significant role in any driver's routing decision, and thus his or her willingness to travel extra miles or absorb highway tolls.

As part of the study, the Reebie Associates consulting team conducted a number of telephone interviews with motor carriers to determine what factors were included in their routing decisions, and how they selected among tolled and non-tolled highway routing alternatives. These carriers represented a broad cross section of the industry, and included companies of different size, scope, service level, and organization. The Reebie Associates consulting team also interviewed some private fleet operators that transported significant volumes of freight on I-81. The interviews yielded the following data that were incorporated into the toll diversion analysis:

4.1.2 Motor Carrier Routing Analysis

Most motor carriers route their vehicles based on operating safety, cost, and time, and there are a number of computer software products available to the trucking industry (via the Internet or as a stand-alone package) that can provide detailed routing instructions based on combinations of projected operating cost, overall mileage, or travel time. These routing products reflect the preferences of the motor carrier industry, and favor the national highway network over secondary roads. Long haul drivers, or those unfamiliar with the regional highway network will generally not improvise routes on secondary roads. Local and regional drivers, more familiar with the area network, are more likely to devise routings that incorporate secondary roads.

Carriers routinely evaluate the relative costs of alternative routes. Internal cost-benefit analyses compare the cost and time trade-offs of toll routes and non-toll alternatives. Based on these analyses, carriers will generally choose the least total cost routing, so long as safety is not compromised. The carriers interviewed believe that most secondary routes are less safe for truck operation than the national network, and are thus generally not considered acceptable alternatives.

Carrier cost analyses commonly include both time and mileage components. Mileage rates of between \$0.44 and \$0.50[7] per mile are used to capture the cost of circuitous miles, while time is factored at between \$20 and \$25 per hour of delay.

Among the independent drivers and owner operators, some reported being reimbursed for tolls, while others were not. These individuals indicated they conduct their own cost analyses to determine the optimal routing for each load.

4.1.2.1 Do Carriers Recover the Costs of Tolls from Shippers?

Carriers interviewed reported that they attempt to incorporate the toll costs in their pricing where the required routing forces the use of toll routes. These efforts do not always result in full cost recovery. Where pricing is done on an annual contract basis, adjustments for newly implemented tolls are negotiated, but the motor carrier commonly absorbs cost changes mid-contract.

Carriers reported that toll costs represent an average of two to three cents per mile overall, but that specific lanes can cost significantly more.

4.1.2.2 Who Makes Routing Decisions?

The trucking firm generally makes routing decisions for company drivers, while independent and owner operator drivers ordinarily make their own individual routing

[7] The cost per mile figures varied slightly by individual carrier, and was somewhat dependent on the specific driver payment schemes employed by the carrier.

decisions. Some of the stated routing policies identified during the motor carriers survey process included: (1) avoid toll routes, (2) avoid toll routes except when secondary highways are the alternative, (3) avoid toll routes with specific cost, time or mileage penalties, and (4) always use toll routes.

4.1.2.3 Are There Any Notable Exceptions?

With some commodities and services, the importance of speed is the primary decision criteria, and these drivers and companies will prefer any route – toll or free – that minimizes travel time. Express package delivery; just in time manufacturing shipments, and very high value commodities represent examples of this. Alternatively, hazardous materials must follow specific routings, and thus have little or no routing freedom.

Cargoes that require special security are also less influenced by tolls, as are LTL movements that generally moved between a fixed network of terminals located along interstate highways.

4.1.2.4 How is Toll Payment Accomplished?

For the motor carrier, the process of paying tolls combines issues of policy and technology. Tolls are either paid in cash, or with an automated mechanism (e.g. radio frequency tags, or passive systems as those proposed by Star Solutions). Payment in cash or with credit card requires stopping the vehicle at the toll plaza. The time to slow, queue, stop, pay, and accelerate can be as little as three minutes or as much as fifteen minutes per tollbooth, depending on traffic conditions. For tollbooth collection systems, companies that own equipment will likely use an automated toll payment system such as E-ZPass^{sm}. Otherwise, drivers will be required to pay cash and submit receipt for reimbursement. Not surprisingly, motor carriers are strong proponents of automated or passive toll collection systems.

4.1.3 Conclusions from Motor Carrier Survey

The following conclusions were drawn from the survey and were incorporated in the diversion analysis.

- Carriers believed that the very long-haul (750 and up) and the very short-haul (less than 250 miles) traffic were most susceptible to diversion from tolling because these movements can select among more numerous alternative routings that can offer lower cost and minimal circuity. Traffic in the 250-750 mile length of haul will find few acceptable alternative routings to I-81, and are thus less likely to divert.

- Individual owner operators and small carriers will be more likely to divert than will larger carriers operating company equipment. Secondary roads are generally not considered an acceptable alternative for long-distance (750 or more miles) truckload carriers.

- Hazardous materials, time sensitive cargoes, LTL Traffic and cargoes requiring high levels of security will be less likely to divert from approved interstate routings, but all alternatives will be considered.

4.2 Diversion Modeling Methodology

The diversion methodology used in this study follows the established general methodologies used by Reebie to produce analyses of highway and intermodal freight in the past 20 years. Reebie's TRANSEARCH database, a comprehensive record of intercity freight traffic first developed in the 1970's, was used as the basic traffic volume estimate. The flows were routed over the U.S. National Highway Network using a model developed by Oak Ridge National Laboratory. Reebie's Truck Cost Allocation Model, combined with projected tolls, survey, and congestion data, was used to calculate costs for a route via I-81 and the next-best alternative. Route choice was then based on selecting a least cost alternative, and reflects the methodology adopted by motor carriers conducting parallel analyses to determine route selection. The following section describes the modeling methodology and assumptions in more detail.

4.2.1 The National Freight Flow Model

Reebie's TRANSEARCH Data is a model of freight flows, and contains origin, destination, mode, and commodity detail at a US county-to-county level. More information about the TRANSEARCH model is provided in Appendix A. For this analysis, a TRANSEARCH 1998 dataset – previously purchased by The Virginia Department of Transportation (VDOT), was employed. This original data had previously been factored to reflect 2001 traffic levels using commodity and geographically specific growth factors developed from Reebie's 2001 TRANSEARCH database. This dataset was then factored to 2003 levels using a simple linear trending algorithm, based on actual traffic count numbers supplied by VDOT for Interstate 81 in Virginia. The VDOT traffic counts indicated that on average, truck counts on Virginia highways increased by 8.5% from 2001 to 2003 (see Appendix B). The previously factored TRANSEARCH 1998 flows (adjusted to 2001) were again factored – this time by the 8.5% truck traffic growth number – to simulate 2003 data. This ensured that Reebie analysts were working with the most up-to-date information, and one that validated TRANSEARCH's estimated traffic flow data against well-grounded in empirical observations.

4.2.2 The Shortest-Path Routing Model

To determine the likely impact on traffic patterns of tolling, Reebie analysts applied a shortest-path model developed by the Oak Ridge National Laboratory. The Oak Ridge Model (ORM) takes as its input an origin-destination traffic flow matrix and routes traffic by the shortest path based on fixed impedances that are dependent on link type (i.e. interstates, U.S. highways, and secondary routes). This type of model logic is identical to that employed by many motor carriers, as indicated in the survey results.

By implication, the model assumes that the U.S. Interstate network is operating at or close to its original design speed. The model does not however, address the effects of highway congestion. This may be a factor in determining the likelihood that an alternative route is preferred. The most significant choke point (leading to highways periodically operating at speeds lower than 60% of design speed) affecting I-81 routing alternatives is congestion along I-95. To adjust travel time for motor carriers using an alternative I-95 routing, we accounted for this as a cost (See Section 4.2.3).

The ORM model was calibrated to produce routing under three scenarios: (1) the base scenario, involving the use of I-81; (2) diversion through a northwesterly route (mostly a combination of I-64 and I-79), with Virginia portion of I-81 unavailable; (3) diversion through a southeasterly route (i.e. I-95), with I-81 unavailable. A sample of the routings produced by ORM were compared to results using ALK Technologies' PC*Miler® software[8]. Two examples of the model determined "Preferred Route" and the "Next Best Alternative Route" appear in Appendix C**.**

---

[8] While several commercial products are available to calculate miles, we selected the widely used PC Miler® product from ALK because it provides a decidedly commercial vehicle (truck) bias, and is easily customizable for route preferences. Many Internet based products do not readily distinguish between designated or preferred truck routes and passenger vehicle corridors. The PC Miler product provides this feature, and is thus consistent with the basic ORM logic.

For a small subset of origin-destination pairs, the ORM model derived alternative routings that included significant penalty mileage. These lanes generally included intra-county flows and inter-county flows for adjacent counties (although a few longer-haul lanes were also identified). A sample set of these lanes was analyzed to develop alternative routings, and again compared to results developed using ALK Technologies' PC*Miler® software. Reebie analysts then determined individually the appropriate level-of-service and mileage impacts for these lanes, where diversions to local U.S. routes and secondary highways were likely. These subset data were then recombined with the original records. The combined dataset contained county origin, county destination, commodity, equipment type, routing via I-81, and next best routing if I-81 were unavailable for all lanes. The commodities were mated to the expected equipment type using data developed by Reebie Associates for the Federal Highway Administration. This dataset provided the input for the economic analysis which considered the impact of various levels of I-81 toll on motor carrier route choice.

4.2.3 The Truck Operating Cost Model

Reebie's Truck Cost Analysis Model (TCAM) was used to estimate the marginal cost of transportation per mile for each equipment type, using all origin-destination flows. This cost function was then further disaggregated into labor (mileage dependent) and equipment life-cycle cost (time dependent) using the carrier survey data discussed separately. We chose not to address differences in cost functions due to: (1) How the operators are being paid, employee versus owner-operators, (2) Fuel costs due to different terrain and operating characteristics, because we believe labor costs and time-dependent fuel costs (tractor idling time) are good proxies for the aforementioned effects. In general, the cost functions amounted to about 40-50 cents per mile for labor, and about $15-$30 per hour for equipment and fuel, depending on the type of rig and speeds operated.

We also chose also not to address the value of inventory-in-transit for a variety of reasons. The cost of inventory-in-transit is mainly driven by the 95th percentile trip time and not the average trip time; in other words, a slower and more reliable service may result in lower total logistics costs than a faster and more variable one. Given the magnitude of delays typically incurred by avoiding I-81 (about 0.5-2.5 hours), this value is typically not recaptureable. Distribution center and small package traffic, that are typically most valuable and time-sensitive, generally have sufficient slack time to absorb the delay without compromising other processes in the logistics chain. For the minority of cases where the delay would result in disruption, it is generally possible to re-engineer the distribution chain, absorb the costs, or pass the costs to the customer. Thus, the value-of-inventory is unlikely to affect diversion behavior or truck operating costs significantly.

The likely congestion on I-95 through Washington D.C. is considered a significant economic cost to truckers. In addition, I-95 boasts a large number of tolls, all of which change the economics of truck operation. To calculate the impact of this congestion on motor carrier routing choice, we utilized data from VDOT's I-95 Roadside Survey (conducted in October of 2002) to estimate the volume of trucks moving on the highway that could be impacted by highway congestion. Out of the average 12,228 Class 8+ trucks traveling on I-95 per day in 2002, 4,453 (36%) passed Dumfries, VA (a suburban location just outside Washington, D.C.) during the morning or evening rush hours (defined as 6am-10am and 3pm-7pm). Using an average delay of 45 minutes estimated based on motor carrier interviews, and average equipment & fuel cost of $27.50 per hour (based on earlier TCAM data and 2002 fuel prices), this delay results in a per-shipment cost increase of $7.43. In addition, between Washington D.C. and New York City, trucks must pay approximately $10.50 in highway tolls.[9] Allocating this cost over the 300 miles of I-95 in the Northeast, this results in a surcharge for trucks accessing the Northeast from the South of about 6 cents per-mile. This surcharge was applied to all flows that reflected I-95 mileage in the Northeast either for the primary or alternative routes. With the congestion and I-95 toll adjustments in place, we initiated a process of calculating potential diversions based on the application of various toll levels to I-81 in Virginia.

4.2.4 The Traffic Diversion Model

The Traffic Diversion Model assumes that the trucking industry behaves in an economically rational manner. Regardless of external factors such as: scenery, family visitation, gradients, and personal preferences, the trucker will always take the cheapest route (having accounted for the full cost of labor, equipment, fuel, congestion, and tolls). The decision variable is thus binary for a given level of toll. This methodology is consistent with motor carrier operating practice, as outlined in Section 4.1.2 above.

The result of the model is a database detailing origin, destination, commodity, equipment type, tonnage, loads, shortest path miles, diversion penalty miles, I-81 miles, toll cost, congestion cost, diversion fuel, equipment, and labor cost, as well as the driver's best economic routing decision at different levels of toll, and its implication on I-81 loads and VMT. In reality, at least some drivers are likely to make decisions based on qualitative

---

[9] I-95 Toll locations were developed from ALK's PC Miler product, and from secondary source data including the following: http://www.usastar.com/i95/tolls.htm; http://www.state.nj.us/turnpike; http://www.mdroads.com/routes/is095.html.

factors, especially when traffic levels are low. However, the likely impact of these variables is modest as such decisions are generally irregular, or spontaneous. Motor carriers expressed a distinct preference for economic routes that become familiar to regular drivers and thus improve safety and performance.

At peak season, the opportunity cost of the equipment increases, and far more trucks are likely to take the toll road than the "average" equipment cost per-hour used in this survey would predict. Independent and small-company drivers, knowing that they have a return load waiting and a demanding customer, are likely to absorb the cost of a faster toll road. On the other hand, when traffic levels are low, more diversions would occur. Over the long run however, the impact of these seasonal variances is diminished, and traffic levels will average out at the levels predicted by the economically driven binary model.

5. Conclusions

The analysis addressed level of tolls between one penny and 40 cents per mile. Up to 12 cents, the diversion impacts are small, accounting for approximately 16% of vehicle miles and 24% of the loads. However, given the importance of safety as a constraint in route selection, this number must be tempered to reflect those vehicles that are currently choosing I-81 for non-economic reasons. At zero toll level, the model predicts that 13% of loads are currently routed on I-81 despite it being a higher cost (in terms of labor and equipment usage) option. If these loads were assumed to be captive for other reasons (such as safety and time), a toll of 12 cents per mile would produce a mere 11% diversion of loads.

The vehicle miles diverted sharply increases between 12 and 30 cents per mile, before leveling off again as only truly captive traffic remains at toll levels above 30 cents.

5.1 Commodity Profile of Diversions

No single commodity segment was found to be unduly affected by tolls on the Virginia segment of I-81. Some shipments of coal were found to be particularly susceptible to diversion even at low rates of toll, while others were found to be economically captive to I-81. This result is unlikely to be solid, as geographic sourcing occurs in all bulk commodity markets, and the toll on coal trucks may have the effect of making Virginia coal mines comparatively less competitive (or, indeed, make rail-served Virginia coal mines comparatively more competitive).

Empty truck relief was found to be a poor way of addressing concerns of local communities who prefer not to have heavy trucks traveling on secondary routes and Main

Streets. A better way of addressing this diversion concern would be to give rate relief to bulk traffic that generates a significant volume of secondary road diversions, but has a relatively low ability to pay. Another method might be to develop alternative bulk transportation solutions, such as improved rail access to coal mines and gravel pits.

The majority of shippers surveyed indicated that for chemicals, hazardous materials, and other specialty goods, secondary routes are not considered an option because of the additional risk exposure faced by the firm due to the possibility of an accident. While it is recognized that some individuals will elect to take those risks, the economic analyses demonstrates that secondary route options are not without costs in terms of lost productivity. If the tolls are set at the levels recommended in this study, carriers are likely to find the time benefits of the tollway exceeds the cost of the toll.

5.2 Distance and Route Profile of Diversion

As addressed in Section 3.6, for low level of tolls, Virginia customers are expected to shoulder about a third of the toll burden, while interstate customers will pay the remainder. Local and regional truckers are more likely to divert at low levels of toll, and at least some the traffic is likely to divert to parallel secondary routes such as U.S. 11 and U.S. 29. It is likely that a toll payment technology which minimizes the delay associated with toll routes can mitigate this problem to some degree, as local truckers, whose routes are characterized by frequent entry and exit from the interstate system, represent a market segment that is very likely to use an automated payment technology.

The analyses conducted for selected origin-destination pairs indicated that transcontinental freight and at least some of the mid-distance freight have many alternatives to I-81, and the impact of their diversion is likely to be felt equally across the entire interstate system. Since this market segment makes up a small portion of total freight volumes, the effect is likely to be negligible.

The Oak Ridge analysis was explicit in its assignment of second-best routes, either I-95 via the Eastern Seaboard, or I-64/I-79 by passing the Shenandoah Valley to the north. Approximately 45% of all flows are diverted to the I-64/I-79 routing, while another 45% divert to the I-95 alternative. However, diversions to local routes – particularly U.S. 11 – are likely to be very noticeable if the mitigation measures discussed earlier are not implemented, for two reasons: (1) The 10% of flows that are likely to divert locally tend to be very high-volume bulk flows with large annual tonnages, with short-distance movements such as coal, aggregates, ores dominating the commodity groupings. These flows account for *between one-third and one-half of all tonnage diverted* (despite being a smaller portion of I-81 vehicle miles (VMT) diverted); (2) Out of the aforementioned 10%, even if only a portion of this traffic is diverted to local secondary routes, the result is likely to be a large increase in truck volume on the secondary routes. Section 3.5 quantifies the impacts on a route-by-route basis.

Generally the result of the analysis suggests that mitigation for bulk traffic (either through rail access or toll relief) could be a particularly important factor in minimizing the negative effects of tolling on Virginia communities and businesses, particularly those along U.S. 11.

6. Implications for Virginia Economic Development

The economic impact of Virginia I-81 tolling is likely to be felt only in the parts of Virginia whose accessibility would be severely impacted by the I-81 tolls. The impact is likely to be most severe in those areas where the economy is not broadly diversified, and whose primary industries are heavily dependent on motor carrier transportation.

Virginia generally has a diversified economy ranging from farming and livestock to electronics and information services. However, this diversification is not geographically uniform, and some areas, notably the large cities, are much more diversified than rural areas and small towns whose foci are farming and raw materials processing. Jurisdictions such as Charlottesville City, Galax City, Montgomery County, Essex County and Appomattox County have industrial mixes that show a high dependence on transportation and thus a high sensitivity to changes in the cost of transportation such as might result from I-81 tolling. These jurisdictions are identified as such due to a high concentration of industries such as: Stone and clay products (SIC 36), Paper containers and boxes (SIC 25), Industrial chemicals & fertilizers (SIC 27), Primary Iron & Steel (SIC 33). Not surprisingly, these are industries that involve bulk consumption of raw materials or generation of bulk products/by-products. Rail transportation can mitigate some of the truck toll costs, although if the manufacturing site is not already rail connected, the options open to the enterprise can become somewhat limited.

While the study linked the identified diversion impacts to industrial sectors, it does not report results based on local employment data. Such an analysis would require a regionally calibrated input-output model, as might be employed in a more extensive economic impact analysis.

7. Policy Implications

The analysis suggests that the application of tolls to I-81 engenders a number of risks that could impact the Commonwealth economy, and the safety of its citizens. The measured application of sound toll policy could moderate many of these impacts, and still permit the dual goals of improved highway safety and capacity to be realized.

Appropriate toll levels are needed to manage risk to Virginia industries. A steep increase in the cost of transportation could affect the livelihood and ambiance of the cities and towns for which Virginia is nationally renowned. The magnitude of risk is not known, but potentially cities could see a small but not unnoticeable job loss if toll levels are set inappropriately high.

Appropriate toll levels are needed to manage risk to Virginia secondary roads. A high level (more than 20 cents per mile) of toll could potentially drive regional truckers operating to Virginia destinations off I-81 and onto local secondary roads. These secondary roads may or may not have appropriate by-passes through heavily populated urban areas. The effect of the truck volume increase will be clearly noticeable for the towns located along these routes.

Appropriate toll levels are needed to manage risk to I-81 Revenue. A high level of toll would divert sufficient traffic to the point where the incremental revenue would not compensate for the loss in business, or the impact on alternative routes.

Appropriate mitigation measures may help reduce risk for Virginia's bulk industries. Industries requiring bulk movement of goods – in particular the mining industry – could be negatively impacted by even modest levels of toll (even if truck transportation is only required as drayage from mine to a rail access point), as bulk commodities are subject to geographic source competition. Enhanced rail access or rate adjustments could both be effective measures to safeguard the future competitiveness of Virginia's bulk product industries.

Toll exclusions for empty truck movements do not appear to offer substantive relief. Since Virginia truckers are as likely to travel empty as interstate truckers, exclusion for empty trucks will result in a loss of revenue without altering the distributional balance between Virginia and non-Virginia truckers. If empty trucks must be excluded, the optimum rate for loaded trucks would be doubled to between 20~40 cents per mile, instead of 10-20 cents per mile recommended in this study.

Toll exclusions for local freight movements may be helpful in mitigating secondary road impacts. With a system such as EZ-pass^{SM}, relief could be given to users who frequent the same segment, who are also most likely to be Virginia local freight carriers. An appropriate fare scheme might incorporate volume discounting such as:

1. The EZ-pass would deduct credit from a pre-paid account at single-trip rates until the truck logs more than a predetermined number of trips between two fixed points in a given period, no more than a set number of miles apart.

2. Thereafter, the toll agency would deduct a reduced rate for further travel between the two fixed points.

3. Those that travel irregular origin-destinations would not qualify.

Exclusion for specific commodity classes does not appear necessary. With the possible exception of coal, ore, and aggregates, no particular commodity group showed particular sensitivity to the cost of tolls, or an above-average representation of Virginia truckers. The policy for mitigating economic impact to the bulk sector may lie with both rail investment, and toll rate relief.

This page intentionally left blank

Report Appendices

This page intentionally left blank

Appendix A

Reebie Associates TRANSEARCH® Database

TRANSEARCH is an integrated, multimodal freight flow database constructed from direct and indirect inputs and modeling techniques. A market research data service of Reebie Associates, it is a proprietary database of freight flows that has been produced annually for two decades. It provides a market-to-market picture of freight traffic movements in the United States, for Canada/U.S., and for Mexico/U.S. TRANSEARCH services are supplied to leading carriers across the U.S. transportation industry as well as to government agencies at the federal, state, and local levels. The database is the leading commercial source of freight traffic information, with a long record of practical guidance to marketing, operating, investment and policy decisions. The current base year is 2003.

TRANSEARCH is constructed from a large number of separate, partially overlapping sources. A major component in the development of TRANSEARCH is the conversion of many different information sources into a single, common framework. Not all sources are equal. Economic modeling is used to aid in the design where data are lacking or confidential, and to check such factors as spatial patterns and logic. The domestic database is built from approximately 100 sources. To supplement these sources Reebie Associates has established an ongoing motor carrier data exchange program. The program, which was instituted to validate information about spatial patterns of truck traffic, has been an effective way to confirm traffic patterns in TRANSEARCH. Truck information received in the exchange program amounts to over 60 million shipments. Over 250 computer programs and processes are necessary to create the final product. Exports and vessel-borne imports are included. NAFTA trade is captured from foreign and federal information.

Records display annual dollar value and tonnages moved by market pair, by commodity and seven modes of transportation. Thus a record for domestic U.S. contains an origin market area, destination market area, commodity code (Standard Transportation Commodity Code – STCC or Standard Industrial Classification – SIC) and alpha commodity description, volume in each traffic lane, plus volume for for-hire truckload, for-hire less-than-truckload, private truck, rail carload, rail/truck intermodal, air and water. Market definition can be at the county, Business Economic Area (BEA), metropolitan area, state or province level. Volume can be expressed in terms of tons, vehicles, value, or VMT. TRANSEARCH also includes information on secondary traffic; freight re-handled by truck from warehouse and distribution centers.

In 1995 and again in 1997 Reebie Associates was the recipient of R&D investment from the Federal Highway Administration, to stimulate development of highly detailed freight data for state and urban planning, and for policy formation. The resulting TRANSEARCH Visual Database marries county-to-county or zip code freight traffic information with flow patterns over national highway and rail networks. The product is available with custom GIS and database software prepared on commercial platforms, to simplify access and analysis by users. The effect is an extraordinarily close-up look at industrial distribution systems, and at opportunities for investment and economic development.

Some of the recent users include:

- **Railroads:** Burlington Northern Santa Fe, Canadian National, CSX, Norfolk Southern, Union Pacific
- **TL Carriers:** Schneider National, J.B. Hunt, M.S. Carriers, Trimac
- **LTL Carriers:** FedEx East, FedEx West, Jevic, USF Dugan, Yellow Transportation, Roadway Express
- **States:** California, Virginia, Florida, Kentucky, Michigan, Missouri, New York, New Jersey, Texas, Washington, Wisconsin
- **MPOs:** Houston, TX; Minneapolis, MN; New York, NY; Cincinnati, OH; St. Louis, MO; Savannah, GA
- **Others:** United Parcel Service, Federal Highway Administration, Federal Express

Issued annually, the data can cover all modes and commodities, including empty truck movements, international shipping, and truck shipments of non-manufactured goods. Features like external trip ends, vehicle miles traveled, gross ton-miles, and forecasts can be provided, and traffic routed along major modal corridors can be displayed.

The database maps commodity flows (2, 3 and 4 digit STCC) in short tons between geographic entities (states, counties, BEAs) by mode (rail car, rail intermodal, truck load, less than truck load, private truck, air and water) for current year and forecast years.

Some data sources used to compile the database are shown in Figure A.1. The data sources vary by the different modes of transportation. The primary source for railroad data is the Carload Waybill Samples gathered from about 4% of total rail car traffic. Reebie Associates sources this data from the Surface Transportation Board. This data is compiled to provide both volumes and patterns of flow. The primary source for waterborne commodity flows is the Waterborne Commerce Statistics compiled by the Army Corps of Engineers. This data tracks the flow of commodities along domestic lakes, rivers and canals, and is used to develop both volumes and patterns of flow.

Mode	Data Source	Agency/Organization
Rail	Carload Waybill Sample	Surface Transportation Board
Water	Waterborne Commerce Statistics	Army Corps of Engineers
Air	FAA Airport Originating Tonnages Airport to Airport Flows Commodity Flow Survey TRANSEARCH	BTS Office of Airline Information (DOT Form 41) BTS Office of Airline Information Bureau of Transportation Statistics Reebie Associates
Truck	Carrier Data Exchange Program TRANSEARCH Annual Survey of Manufactures Freight Locater Data Service General Statistics for Verification Commodity Flow Survey	Reebie Associates Reebie Associates U.S. Census Bureau Reebie Associates Industry Associations Bureau of Transportation Statistics

Figure A.1: Selection of TRANSEARCH Database Data Sources

The air data is compiled from four major sources. The first is FAA airport originating tonnages primarily from Form 41 reports and compiled by the Office of Airline Statistics (Federal). This source establishes volume estimates at airports. The second source is airport-to-airport (ATA) flows compiled by the BTS Office of Airline information. This data is used to establish flow patterns. The third source is from Commodity Flow Survey (CFS) data, which are used to define the commodity types. The fourth source is Reebie Associates' TRANSEARCH Database, which is used to supplement the CFS data.

The trucking data process is more complex and comes from a wide variety of sources developed over the course of 20 years. However, there are four primary sources. The first is a data exchange program Reebie has with motor carriers, which is used to estimate patterns and volumes. The second source is a variety of industry associations (timber, plastics, chemical, automotive, etc.), which provide overall volume information for the respective industry sectors. The third major source is from the Annual Survey of Manufactures, primary employment and output data by industry, distributed at the state and local level. This data maps production and consumption of commodities and is used to calibrate the trucking flows. The Freight Locater data service is a database of industrial facilities and their exact location. This data supplements the previously mentioned sources to help calibrate the flows of goods between specific geographic entities.

Data Issues and Limitations – Reebie Associates developed a finer detail version of its TRANSEARCH database in an FHWA sponsored project known as the Intermodal Freight Visual Database (IFVDB). It breaks down origin and destination market areas to the county level and is compatible with GIS applications. It has been incorporated into TRANSEARCH, with its most current base year as 2003. The 1998 edition of this database is the primary source for the Virginia I-81 study, and the traffic patterns are factored up to 2003 levels using a constant growth factor at the client's request. For this study, TRANSEARCH data were identified at varying levels of detail, including county, state, and BEA regions.

TRANSEARCH reports provide a broad picture of freight traffic movements in the United States. It is generally understood that large databases of this kind are never perfect, and TRANSEARCH is not an exception to the rule. It is, however, the best available source of its kind in the cognizance of the study team. TRANSEARCH is in use by virtually all major U.S. railroads and by of motor carrier companies and several container shipping lines and air cargo carriers. State and federal planning agencies, as well as port authorities, equipment suppliers, investment banks and judicial and regulatory bodies also use it.

Appendix B

Virginia Highway Traffic Counts from VDOT

Virginia Highways Traffic Counts											
Supplied by VDOT		2001 Counts					2003 Counts				% Change
		Northbound/Both Dire		Southbound		Both Direc	Northbound		Southbound	Both Direc	Truck
Highway	**Segment**	**Vehs**	**Class 8+**	**Vehs**	**Class 8+**	**Truck %**	**Vehs**	**Class 8+**	**Vehs**	**Class 8+**	**Truck %**	**Activity**
I-81	CP1	16116	5505	17115	4999	32%	17264	5763	17119	5335	32%	5%
I-81	CP2	22979	5541	23865	5719	24%	24318	6134	23833	5570	24%	4%
I-81	CP3	24669	5933	24066	5933	24%	26815	6672	23789	6129	25%	7%
I-81	CP4	18736	5429	17411	4859	28%	21850	5627	20433	4947	25%	3%
I-81	CP5	26857	5839	26529	5586	21%	29233	6060	28468	5807	21%	2%
I-81	CP6	26853	5788	26894	5238	21%	27932	5826	29219	5406	20%	2%
I-81	CP7	20507	5599	17786	5602	29%	21266	6494	20794	6091	30%	11%
I-81	CP8	19824	4662	19254	4058	22%	21122	4598	20557	3982	21%	-2%
I-64	MP043-05	3699	932	4222	1012	25%	4367	1020	4453	1041	23%	6%
I-64	MP095-09	14749	1579	15079	1854	12%	15985	1871	16065	1864	12%	8%
I-64	MP137-14	11964	1090	12067	2051	13%	13125	1515	13105	1475	11%	-5%
I-64	MP180-18	41859	1457	41978	1651	4%	—	—	46388	3404	7%	9%
I-64	MP196-19	24210	1594	25013	1340	6%	22197	1151	23535	1024	5%	-35%
I-64	MP257-25	59104	2132	57595	2120	4%	60160	2306	60356	2173	4%	5%
I-95	MP000-00	18286	3306	18433	3344	18%	19657	3328	19972	3579	17%	4%
I-95	MP041-04	18912	3022	18638	3050	16%	19926	3253	20053	2890	15%	1%
I-95	MP056-05	38507	3494	39005	—	5%	44049	5339	43718	3779	10%	23%
I-95	MP076-07	66954	4192	68158	5267	7%	70017	5145	71381	5873	8%	14%
I-95	MP081-08	46133	4282	45145	—	5%	49458	3983	48381	4600	9%	0%
I-95	MP086-08	51293	6560	46638	7082	14%	54011	6899	54482	7537	13%	6%
I-95	MP118-12	43325	5835	43075	6299	14%	45250	6223	46126	6778	14%	7%
I-95	MP140-14	59749	5672	59488	5515	9%	63876	5797	62690	6732	10%	11%
I-95	MP174-17	71759	5514	76096	7706	9%	69800	5839	72730	7986	10%	4%
US11	MP007-00	9767	100	—	—	1%	8878	125	—	—	1%	20%
US11	MP103-10	13363	133	—	—	1%	13079	141	—	—	1%	5%
US11	MP150-15	12374	134	—	—	1%	12609	330	—	—	3%	59%
US11	MP156-15	14063	61	—	—	0%	13747	128	—	—	1%	52%
US11	MP325-32	15040	1610	—	—	11%	16475	554	—	—	3%	-191%
US29	MP001-00	10787	2180	—	—	20%	10439	1782	—	—	17%	-22%
US29	MP033-03	8361	1484	—	—	18%	8221	2140	—	—	26%	31%
US29	MP066-06	25193	1817	—	—	7%	27451	1605	—	—	6%	-13%
US29	MP105-11	12224	1318	—	—	11%	12307	1294	—	—	11%	-2%
US29	MP144-14	35713	1549	—	—	4%	36219	1478	—	—	4%	-5%
US29	MP156-16	13943	1279	—	—	9%	14205	966	—	—	7%	-32%
US29	MP210-21	42360	1984	—	—	5%	43769	1880	—	—	4%	-6%
Total/Weighted Avg		**1703782**	**198892**			**11.7%**	**1746724**	**217270**			**12.4%**	**8.5%**

This page intentionally left blank

Appendix C

Sample "Preferred" and "Next Best Alternative" Routings[10]

[10] Graphics and route alternatives for sample lanes developed using ALK's PC Miler® truck routing product.

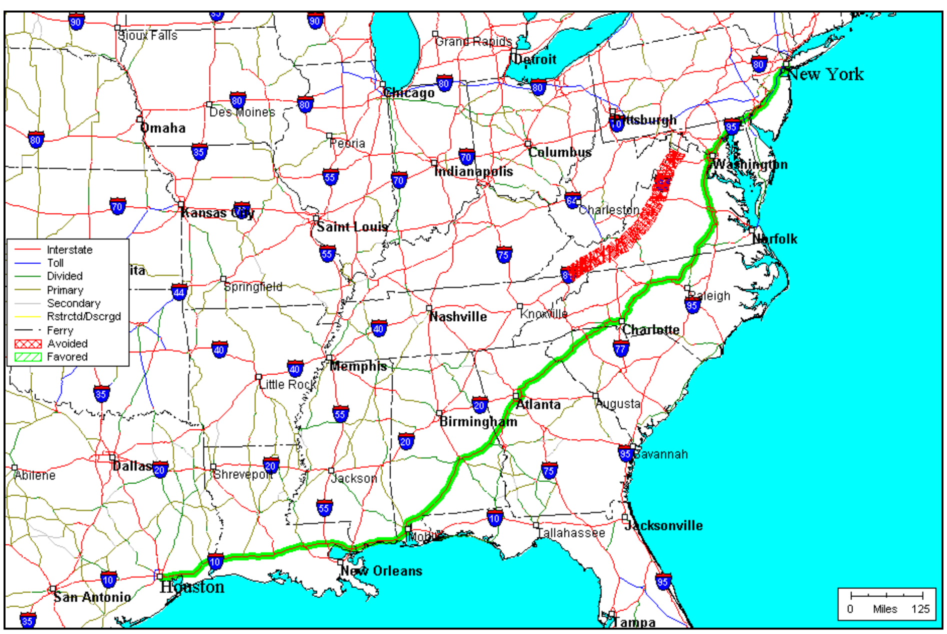
Preferred Routing – Memphis, TN to New York, NY

Next Best Alternative Routing – Memphis, TN to New York, NY

REEBIE

Preferred Routing – Houston, TX to New York, NY

Next-Best Alternative Routing – Houston, TX to New York, NY



This page intentionally left blank

Appendix D

Table of Assumptions

In the course of the Diversion Analysis, Reebie Associates has made the following assumptions:

1. *Tolls would be applied on a uniform mileage basis along the I-81 Corridor.*

   The linear relationship between I-81 miles traveled and toll cost permitted the analysis to consider the impacts uniformly, and identify opportunity and risk areas for the application of different toll levels.

2. *Toll costs would be applied uniformly by commodity area.*

   The equal application of tolls to all commodity groupings allowed an unbiased impact analysis, and helped identify areas of risk that could be addressed through concession.

3. *TRANSEARCH volumes and distributions are representative of the current and projected I-81 traffic mix.*

   The mileage and commodity distributions of TRANSEARCH were analyzed as a proxy for "perfect information" with respect to the current and projected distribution of I-81 traffic including: origins and destinations, volumes, commodities, truck body types, and driver and carrier associations.